



SINGLE POINT ADJUSTMENTS: A NEW DEFINITION WITH EXAMPLES

David C. Bachman

Disciplined maintenance of the Performance Measurement Baseline is essential for Earned Value Management. A stable baseline provides the earned value (EV) analyst with the metrics needed to bound a project's Estimate at Completion (EAC) range. A single point adjustment (SPA) is made when a contract's existing cost and/or schedule variances are set to zero and all the remaining work is replanned with the goal of completing the project on schedule and on budget. The SPA obscures past performance, collapses the EAC range, and makes the resulting EAC unreliable. The origin of SPA, four recent project SPAs, and the SPA effect on the project's EACs are examined. A new SPA definition is recommended for EV glossaries that currently omit this topic.

I recently joined the Ballistic Missile Defense Organization (BMDO) as an Earned Value Senior Program Analyst. One of my first BMDO assignments was to explain a term I was unfamiliar with — *single point adjustment*. The term single point adjustment (SPA) is not defined in current versions of the Defense Contract Management Agency's (DCMA) *Earned Value Management Implementation Guide* (DCMA, 2001), the *Earned Value Guidebook* (DCMA, 2000) or the Defense Systems Management College's (DSMC) *Earned Value Management Textbook* (DSMC, 1999). In this paper I will share the historic origin of the term, the effects that contractor-initiated SPAs have had on actual BMDO contract Earned Value (EV) metrics and the Estimate at

Completion (EAC), and recommend a new SPA definition for earned value glossaries that currently omit this topic. Although I review the Earned Value Management (EVM) estimate at completion concept, I do not provide extensive review of basic EVM concepts that can be found in the *Earned Value Guidebook* (DCMA, 2000).

SINGLE POINT ADJUSTMENTS HISTORICAL DEFINITION

The origin of the term single point adjustment is found in historic U.S. Air Force (USAF) Cost/Schedule Control System Criteria (C/SCSC) documentation (USAF, 1986). The term single point

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 01-06-2002		2. REPORT TYPE		3. DATES COVERED (FROM - TO) xx-xx-2002 to xx-xx-2002	
4. TITLE AND SUBTITLE Single Point Adjustments: A New Definition with Examples Unclassified			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) Bachman, David C. ;			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME AND ADDRESS BMDO XXXXX XXXXX, XXXXXXXX			8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS OUSD(AT&L) Acquisition Resources & Analysis/Acquisition Management ,			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT APUBLIC RELEASE ,					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT See report.					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:		17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19. NAME OF RESPONSIBLE PERSON	
		Public Release	20	http://www.acq.osd.mil/pm/paperpres/paperpres.html (blank) lfenster@dtic.mil	
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified	19b. TELEPHONE NUMBER International Area Code Area Code Telephone Number 703767-9007 DSN 427-9007		
				Standard Form 298 (Rev. 8-98) Prescribed by ANSI Std Z39.18	



adjustment describes an event when a contract's existing variances (Schedule Variance [SV],¹ Cost Variance [CV]²) are zeroed in a single reporting period and the remaining portion of contractual work is rebudgeted to establish a new performance measurement baseline (PMB³) (Finefield, 2000). Unlike an over-target baseline, the goal of an SPA is to develop

"A character trait shared by many program managers is a belief they will complete their project on schedule within budget."

a new PMB that completes all the remaining work using only the remaining budget from the original PMB. No additional (over-target)

budget is added to the new PMB. Likewise, SPA differs from a classic rebaselining because the new PMB includes no new work scope and is completed without a schedule slip. Tony Finefield provides a historic origin for the term in an Office of the Secretary of Defense (OSD) Earned Value Management Noteboard posting:

The term evolved from a statement in Air Force Regulation 800-6/AFSC Supplement 1, dated 31 December 1986. In the discussion concerning Over Target Baselines [OTB], this supplement describes the conditions where Headquarters AFSC [Air Force Safety Center] concurrence in the establishment of an OTB was required. One of these conditions was stated as: "If the contractor proposes making adjustments to current or past cost and schedule

variances at other than a single point in time (current period)."

Because of this requirement, the question concerning this "single point adjustment" became part of the lexicon of C/SCSC. (Finefield, 2000)

RECURRING THEMES IN EARNED VALUE MANAGEMENT

Three recurring themes are found throughout much of the published works dealing with Earned Value Management: 1) program managers are optimists; 2) programs don't improve; and 3) generalizations are made about a contract's EAC range based upon selection of specific EAC equations (or performance factors). All three themes help explain the effect that single point adjustments have on BMDO earned value metrics and the resulting estimate at completion calculations.

A character trait shared by many program managers is a belief they will complete their project on schedule within budget. This optimism often leads to advocacy and the suppression of unfavorable estimates at completion. In the wake of the Navy's A-12 Program, D.S. Christensen examined 64 contracts to evaluate cost overrun optimism (Christensen, 1994). He found both government and contractor estimates at completion to be overly optimistic, with the average under estimate ranging from 4 to 8 percent. In the same paper, Christensen quoted a finding from the *A-12 Administrative Inquiry* (Beach, 1990). C.P. Beach opined that the need to present an optimistic picture was a dominant consideration for suppressing



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more realistic estimates and that this was an “abiding cultural problem” for major defense programs. In later research, Christensen demonstrated that government and contractor EACs were correlated to the lower bound of an EAC range and the higher and traditionally more accurate EACs were ignored (Christensen, 1996).

A strong argument for Earned Value Management is the ability to project trends. When a contract is more than 15 percent complete, two highly researched and generally accepted assumptions can be made: 1) Overrun at completion will not be less than overrun incurred to date; and 2) Percent overrun at completion will be greater than percent overrun incurred to date (W. Abba, personal communication, September, 1992; Christensen, 1989; Heise, 1991; Wilson, 1991).

A primary function of the earned value analyst is to evaluate program cost, schedule, and technical trends to generate an Estimate at Completion. Options available for computing EACs fall into three broad categories: 1) risk-based EACs; 2) regression-based methods; and 3) index-based formulas. Risk-based EAC research is not as extensive as the other two categories. Risk-based EACs look forward rather than backward by computing a most-likely cost applying probabilities of best- and worst-case outcomes. After implementing risk-based EACs, Boeing Corporation realized big gains in the quality of analysis, EAC accuracy, and the overall usefulness of EVM (Pakiz, 1998). Regression-based methods use complex regression analysis to model curvilinear cumulative cost growth. No overall superiority of this approach has been established when compared to index-based formulas (Christensen, Antolini, and McKinney, 1995).

Index-based methods are a very common technique for computing EACs, and they are the primary technique used by BMDO. The disciplined maintenance of the PMB is essential for accurate index-based EACs. Essentially, all index-based EACs are derived from one equation (Abba, 1991):

$$EAC^4 = ACWP^5 + [(BAC^6 - BCWP^7)/PF].$$

(Formula 1)

Where ACWP is the sum of actual direct costs, plus indirect costs allocable to the contract, and $[(BAC - BCWP)/PF]$ represents the estimated direct and indirect costs for the remaining authorized work. An EAC range is established by applying different performance factors (PF) to the EAC equation. The cost performance index (CPI)⁸ and the schedule performance index (SPI)⁹ are the primary EV metrics associated with EAC PFs. Performance factors are derived from the CPI (Table 2, Formula 2) and the SPI (Table 2, Formula 3) and take one of three forms:

1. single indexes (e.g., CPI_{cum} , CPI_{3mth} , SPI_{cum});
2. weighted indexes (called composite index in some papers, e.g., $[0.8 CPI_{cum} + 0.2 SPI_{cum}]$, $[0.3 CPI_{manufacturing} + 0.4 CPI_{test} + 0.3 CPI_{procurement}]$); or
3. composite indexes (called schedule cost index [SCI] in some papers, i.e., $[CPI_{cum} \times SPI_{cum}]$, $[CPI_{6mth} \times SPI_{cum}]$). Selecting the proper PF determines the ultimate management value of any EAC.



I selected the three PFs identified in the DSMC EVM textbook to evaluate the EAC range: CPI_{cum} ; $(0.8 CPI_{cum} + 0.2 SPI_{cum})$; and $(CPI_{cum} \times SPI_{cum})$. The results of two EAC studies indirectly support the condition that using CPI_{cum} as the performance factor establishes a lower bound for the final contract cost (Christensen and Heise, 1993; Haydon, 1981). For contracts with unfavorable (less than 1.0) SPIs and CPIs, the composite performance factor ($CPI_{cum} \times SPI_{cum}$) establishes an upper bound. Review of 64 contracts shows this PF to be the best predictor of actual final cost (Christensen, 1996). This leaves the weighted performance factor $(0.8 CPI_{cum} + 0.2 SPI_{cum})$ to hold the middle position.

The Headquarters Air Force Material Command's, *Guide to Analysis of Con-*

tractor Cost Data recommends using the weighted performance factor because "various studies have shown this to be a reliable forecast-

"The data in this paper are normalized to standardize the results and to conceal the actual program identities."

ing formula" (Department of the Air Force, 1994). This assertion is not supported by academic EAC research (Christensen, Antolini, and McKinney 1995). The four SPAs examined in this paper fall into the two contract status categories listed in Table 1. Applying Christensen's research, both categories generate the same EAC relationship — the composite PF generates the highest EAC, and the CPI_{cum} PF generates the lowest EAC.

METHODOLOGY

The data in this paper are normalized to standardize results and conceal actual program identities. BMDO has 13 active projects providing earned value management data. Four of those programs have been selected to highlight different types of single point adjustments. The project descriptions are generic in nature and actually apply to a number of different BMDO efforts. The earned value metrics of BCWS,¹⁰ BCWP, and ACWP are represented by Percent Scheduled¹¹ (Table 2, Formula 4), Percent Complete¹² (Table 2, Formula 5) and Percent Spent¹³ (Table 2, Formula 6), respectively. These metrics normalize the data and indicate where in the project SPAs were made. PMB changes appear as step functions in the Percent Scheduled, Percent Complete and Percent Spent metrics. EACs are represented by the Percent Variance At Completion¹⁴ (VAC) metric (Table 2, Formula 7). The Percent VAC metric is specifically selected because its interpretation remains unchanged by PMB changes.

Each program has two figures and one table. Figure A plots BCWS, BCWP, and ACWP normalized as indicated above. The cumulative dollar values for BCWS, BCWP, and ACWP are divided by the PMB dollar value at the end of the given month (using Table 2, Formulas 4–6). A value of 100% always represents all the work of the PMB. As work scope is added to the PMB, the 100% value remains constant and the Percent Scheduled, Percent Complete, and Percent Spent (representing BCWS, BCWP, and ACWP) values are correspondingly reduced to represent the new higher budgets. Note that the PMB, not the Contract Budget Baseline



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(CBB),¹⁵ is used in all three of these metrics.

Figure B plots the three Percent VAC values. Like Figure A, the Percent VAC is based on the PMB not the CBB. Three EACs are generated using Formula 1 with the performance factors: 1) Single Index— CPI_{cum} ; 2) Weighted Index— $(0.8 CPI_{cum} + 0.2 SPI_{cum})$; and 3) Composite Index— $(CPI_{cum} \times SPI_{cum})$. The three Percent VACs are computed using Formula 7 with the three respective PFs. Tables 3 through 6 highlight key data points before and after the SPAs. Note that negative Percent VACs represent projected contract overruns.

CASE 1

Cost as an Independent Variable (CAIV) single point adjustment. The contract is a >\$100 million RDT&E contract for software development with a 38-month period of performance. The software is being written and tested using an incremental development model. In March 1999, the contract is 34% complete and 40% spent, and the EAC indicates an overrun between 20% and 60%. The contractor implements a classic single point adjustment in May 1999 when BCWP and BCWS are both set equal to ACWP. In June 1999, work scope is decreased as part of a CAIV effort.

CASE 2

Work Breakdown Structure (WBS) Level 4 single point adjustment. The contract is a >\$1.5 billion RDT&E contract with a 36-month period of performance. It has numerous subcontract efforts. One >\$400 million subcontract is represented in the Cost Performance Report (CPR)¹⁶ as a Level 4 WBS element.

This subcontract initially has significant scope and under funding issues. A baseline is not established until the subcontract is 35% spent. The prime contractor almost immediately projects and reports a 100% overrun EAC. Two months after establishing the PMB, with the subcontract 50% spent, the subcontract has a -10.4% unfavorable cost variance. A month later the prime contractor makes a single point adjustment to zero the cost variance by setting BCWP equal to

" This subcontract [Case 2] initially has significant scope and under funding issues."

ACWP (BCWS was not adjusted). This improves the subcontract's CPI resulting in on-budget EAC calculations. Despite the recognized need, no over-target baseline is established. Over the next two months, the CV worsened to -10.6% and the SV worsened to -9.6%. At this point the original PMB is 86% spent and subcontract scope and funding issues are resolved increasing the PMB by 150%. The program office then directs that the Level 4 WBS be rebaselined. Adjustments are made to BCWS and BCWP that result in starting the new baseline with a +1.8% favorable cost variance and a -1.1% unfavorable schedule variance. These adjustments result in EAC calculations suggesting a 1% or 2% underrun.

CASE 3

Single point adjustment of BCWS only. The contract is a >\$400 million RDT&E enhancement to an existing weapon system with a 42-month period of performance. Numerous small contract modifications occur throughout the contract's life and



the contract budget base has increased 62% as of the date on these charts. In June 1999, at the 57% complete and 61% spent point, the contract is rebaselined as part of the significant increase in scope. This adjustment is not included in this analy-

"The single point adjustments observed on BMDO contracts are not consistent with the historic definition."

sis. For the six months after rebaselining, the unfavorable cost variance is stable at -2% to -4%, but the schedule variance is

constantly worsening and is -6.4% unfavorable in January 2000. The contractor reschedules all remaining work in February 2000. He also makes a single point adjustment to his PMB by setting BCWS equal to BCWP, resulting in an SPI of one.

CASE 4

Single point adjustment underrun. The contract is a \$50 million RDT&E integration study contract with a 24-month period of performance. In November 1999, at 50% complete and 48% spent, the contract is on schedule with a +4% favorable cost variance. At this point, the government has removed requirements and reduced the contract budget baseline by 8%. For this contract modification, the contractor adjusts the PMB without using a single point adjustment. In March 2000, the contract is 74% complete with a -1% unfavorable schedule variance and a +4% favorable cost variance. These numbers support a \$42 million or \$43 million EAC. The government, desiring to lock in this underrun, advises the contractor that contract funding will be limited to the projected EAC. This unilateral contract

modification is not accompanied by any work scope reduction or adjustment to the contract budget baseline. The contractor is only advised that he should adjust the contracted work scope to complete the contract for the revised funding. In April 2000, the contractor initiates a single point adjustment by setting BCWS and BCWP equal to ACWP. This recategorizes about \$1.4 million worth of completed work (BCWP) as work remaining (BCWR),¹⁷ and the subsequent EAC grows to the original contract budget baseline.

RESULTS

The single point adjustments observed on BMDO contracts are not consistent with the historic definition. The key aspects of the historic definition are: 1) both SV and CV are zeroed in a single reporting period; and 2) the remaining portion of contractual work is replanned without adding new budget authority or slipping the original schedule to establish a new PMB.

1. In Case 1, SV and CV are zeroed in a single month, but the contract is descoped as part of a CAIV effort.
2. In Case 2, the SPA and rebaselining efforts only meet the second aspect of the historic definition. Only the CV is reset to zero in Case 2's SPA. In the rebaselining, the new PMB is established with a significant favorable variance for this element.
3. In Case 3, only the SV is reset to zero by an SPA.



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4. In Case 4, only the first element of the definition is met. With regard to the second element, the remaining work is not only replanned but \$1.4 million of completed work is also reclassified as incomplete.

Single point adjustments distort earned value trend information and collapse the EAC range.

1. Case 1 – EAC range
Before SPA
–21% to –63% unfavorable
After SPA
–1% to –2% unfavorable

2. Case 2 – EAC range
Before SPA
–9% to –10% unfavorable
After SPA
–0% to –2% unfavorable

3. Case 3 – EAC range
Before Rebaseline
–11% to –13% unfavorable
After Rebaseline
+1% to +2% favorable

(Note that in Case 3, contrary to EAC research, the CPI_{cum} PF is no longer the floor of the EAC range.)

4. Case 4 – EAC range
Before SPA
+4% (No EAC range)
After SPA
0% (No EAC range)

Single point adjustments appear to be made to address contract-reporting issues rather than to address program management concerns.

1. In Case 2, the single point adjustments are made when variances, cost or schedule, become 10% unfavorable. Even though the contractor's EAC is known and reported to be twice the PMB, no over-target baseline is established.

2. In Case 3, Table 5 clearly demonstrates that an SPA of BCWS collapses the EAC range, making the CPI_{cum} EAC (traditional low) and the Composite EAC (traditional high) equal. Four months after the SPA, the EAC range is back to the pre-SPA level.

3. Case 4 demonstrates the old cliché “that no good deed goes unpunished.” During the first half of the contract, the contractor maintains schedule and has a favorable cost variance that results in a budget cut. With the contractor continuing this favorable trend throughout the third quarter of the contract, the government seeks a second reduction—this time without eliminating any contract requirements. With no government direction, the contractor initiates an SPA that eliminates 18 months of favorable variances. Four months later, the project generates an overrun for the first time. (During the review of this paper, the project was completed with a +4.0% VAC highlighting the unreliability of index-based EACs following SPAs.)

CONCLUSIONS

1. Statistically significant conclusions cannot be made from only four data points. Especially when these data

points are selected to highlight a variety of baseline adjustments described in CPRs as single point adjustments.

2. The term single point adjustment is taking on a variety of new definitions. The SPAs observed on BMDO contracts are different than the old Air Force Systems Command definition.
3. The favorable results of Case 1 suggest that SPAs should be used only in conjunction with scope, schedule, or budget adjustments that redefine project baselines. Specifically, think in

“Single point adjustments distort earned value cost and schedule metrics and make index-based earned value EAC computations unreliable.”

CAIV terms where either work scope or schedules are modified to achieve a specific cost objective. SPAs should not be used just because additional

work scope has been added or subtracted to the PMB. The findings are consistent with C. P. Beach's opinion that “the need to present an optimistic picture was a dominant consideration for suppressing more realistic estimates” (Beach, 1990). Clearly the SPAs in Cases 2 and 3 are made to support lower EACs, suggesting the SPA has become a tool to suppress unfavorable EACs.

4. Because single point adjustments distort EV metrics and, in the short term, lower EACs and reduce the EAC range following SPAs, other EAC strategies

(risk-based EACs or regression-based EACs) are needed to project realistic EACs. The unique characteristics of the PMB changes made by BMDO contractors highlight the importance of the CPR Format 3 – Baseline¹⁶ and the need for Integrated Product Teams involved in project management to have an analysis-level understanding of earned value management.

5. Additional research into the policy and programmatic and contractual implications of single point adjustments is warranted.

RECOMMENDATIONS

1. The following definition should be added to earned value references: Single Point Adjustment – An arbitrary baseline adjustment at any level of the work breakdown structure where BCWS is set equal to BCWP, BCWP is set equal to ACWP, or both BCWS and BCWP are set equal to ACWP; and incomplete work is replanned to be completed on schedule and within the original PMB budget. Single point adjustments distort earned value cost and schedule metrics and make index-based earned value EAC computations unreliable.
2. Program offices should consider adding language to EVM contracts requiring customer notification and concurrence before single point adjustments are made to baseline reporting documents such as the CPR.



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REFERENCES

- Abba, W. (1991). *Analysis and use of data*. (Presentation material, Contractor Performance Measurement Course, 14:1–43). Fort Belvoir, VA: Defense System Management College.
- Beach, C. P., Jr. (1990, November 28). *A-12 Administrative Inquiry* (Report to the Secretary of the Navy). Washington, DC: Department of the Navy.
- Christensen, D. S. (1989, Fall). Management control systems theory and cost/schedule control systems criteria. *National Estimator*, 29–34.
- Christensen, D. S. (1994, Winter). Cost overrun optimism: Fact or fiction? *Acquisition Review Quarterly*, 25–38.
- Christensen, D. S. (1996, Spring). Project advocacy and the estimate at completion problem. *The Journal of Cost Analysis*, 35–60.
- Christensen, D. S., Antolini, R. C., & McKinney, J. W. (1995, Spring). A review of estimate at completion research. *The Journal of Cost Analysis*, 41–62.
- Christensen, D. S., & Heise, S. R. (1993, Spring). Cost performance index stability. *National Contract Management Journal*, 25, 7–15.
- Defense Contract Management Agency. (2000, August). *Earned value guidebook*. Alexandria, VA: Department of Defense.
- Defense Contract Management Agency. (2001, June). *Earned value management implementation guide*. (DCMA Handbook 2.2-1) Alexandria, VA: Department of Defense. Defense Systems Management College. (1999, December). *Earned value management textbook*. Fort Belvoir, VA: Department of Defense.



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- Department of the Air Force. (1986, December 31). *Air Force Regulation 800-6/AFSC Supplement 1*, Andrews Air Force Base, MD: Department of Defense.
- Department of the Air Force. (1994, April 4). *Guide to analysis of contractor data* (Air Force Material Command Pamphlet No. 65-501). Wright Patterson Air Force Base, OH: Department of Defense.
- Finefield, T. (2000, May 18). Single point adjustment? [Message posted to the Earned Value Management Noteboard]. <http://www.acq.osd.mil/pm/noteboard/messages/1803.html>
- Haydon, J. J., & Reither, R.O. (1981). *A study to determine indicators and methods to compute estimate at completion (EAC)*. Virginia ManTech International Corporation, VA: Author.
- Heise, S. R. (1991, September). *A review of cost performance index stability* (AFIT/GSM/LSY/91S-12). Master's thesis, School of Systems and Logistics, Air Force Institute of Technology, Wright Patterson Air Force Base, OH.
- Pakiz, J.J. (1998, October 18–22). *Summary level variance analysis integrated with risk based EAC*. Paper presented at the 10th Annual International Integrated Program Management Conference, Tysons Corner, VA.
- Wilson, B. D. (1991). *An analysis of contract cost overruns and their impacts* (AFIT/GCA/LSY/92S-8). Master's thesis, Air Force Institute of Technology, Wright Patterson Air Force Base, OH.



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ENDNOTES

1. **Schedule Variance (SV)**—A metric for the schedule performance on a program. It is the algebraic difference between earned value and the budget ($\text{Schedule Variance} = \text{Earned Value} - \text{Budget}$). A positive value is a favorable condition whereas a negative value is unfavorable.
2. **Cost Variance (CV)**—A metric for the cost performance on a contractor program. It is the algebraic difference between earned value and actual cost ($\text{Cost Variance} = \text{Earned Value} - \text{Actual Cost}$). A positive value indicates a favorable position and a negative value indicates an unfavorable condition.
3. **Performance Measurement Baseline (PMB)**—The time-phased budget plan from which contract performance is measured. Budgets assigned to scheduled control accounts and the applicable indirect budgets form the PMB. For future efforts, not planned to the control account level, the performance measurement baseline also includes budgets assigned to higher level CWBS elements and undistributed budgets. It equals the total allocated budget less management reserve.
4. **Estimate at Completion (EAC)**—Actual direct costs, plus indirect costs allocable to the contract, plus the estimate of costs (direct and indirect) for authorized work remaining.
5. **Actual Cost of Work Performed (ACWP)**—The costs actually incurred and recorded in accomplishing the work performed within a given time period.
6. **Budget at Completion (BAC)**—The sum of all established contract budgets.
7. **Budgeted Cost for Work Performed (BCWP or Earned Value)**—The sum of the budgets for completed work packages and completed portions of open work packages; plus the applicable portion of the budgets for level of effort and apportioned effort.
8. **Cost Performance Index (CPI)**—This is an indication of the cost efficiency that work has been accomplished. A CPI can be calculated for both current and cum-to date data. An efficiency index of 1.0 indicates that cost is on target whereas an index of 1.1 would indicate a cost underrun (higher efficiency).
9. **Schedule Performance Index (SPI)**—This is an indication of the schedule efficiency that work has been accomplished. An SPI can be calculated for both current and cum-to date data. An index of 1.0 indicates that the supplier is performing on schedule whereas an index of 1.1 indicates an ahead of schedule condition (higher efficiency).



10. Budgeted Cost for Work Scheduled (BCWS or Planned Value)—The sum of the budgets for all scheduled work packages, planning packages, and so on (including in-process work packages); plus the level of effort and apportioned effort amounts scheduled to be accomplished within a given time period.
11. Percent Scheduled—This is the relationship of the budget scheduled to date (BCWS) to the amount of budget planned for the total contract (BAC).
12. Percent Complete—This the relationship of the amount of budget accomplished to date (BCWP) to the amount of budget planned for the total contract (BAC).
13. Percent Spent—This is the relationship of the amount spent to date (ACWP) to the amount of budget planned for the total contract (BAC).
14. Percent Variance at Completion (VAC)—The difference between the total contract budget (WBS element, organizational entity, or cost account) and the estimate at completion. Variance at Completion = Budget at Completion – Estimate at Completion. It represents the amount of expected overrun or underrun.
15. Contract Budget Base (CBB)—The negotiated contract cost plus the estimated cost of authorized unpriced work.
16. Cost Performance Report (CPR)—A contractually required report, prepared by the contractor, that contains information derived from internal EVMs and provides the status of the contract's progress. The report is delivered in five formats: Format 1 – *Work Breakdown Structure*, (WBS) reports performance to date based on the WBS; Format 2 – *Organizational Categories*, reports performance to date based on the contractor's organizational structure; Format 3 – *Baseline*, reports the planned future performance measurement baseline; Format 4 – *Staffing*, reports the planned future personnel loading; and Format 5 – *Explanations and Problem Analyses*, provides a narrative discussion of contract status, problems and planned corrective actions.
17. Budget Cost of Work Remaining (BCWR)—The difference between the total contract (BAC) and the amount of budget accomplished to date. Budget Cost of Work Remaining = Budget at Completion – Budget Cost for Work Performed.

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Table 1. Inequality Equations

Contract Status	Performance Index Status	EAC Relationship
Unfavorable cost and unfavorable schedule performance	CPI < 1 SPI < 1 SPI < CPI	$EAC_{\text{composite}} > EAC_{\text{weighted}} > EAC_{\text{CPI}_{\text{cum}}}$
Favorable cost and unfavorable schedule performance	CPI > 1 SPI < 1	$EAC_{\text{composite}} > EAC_{\text{weighted}} > EAC_{\text{CPI}_{\text{cum}}}$
<i>Note.</i> From "Project Advocacy and the Estimate at Completion Problem" by D. S. Christensen, 1996, Spring, <i>The Journal of Cost Analysis</i> , pp. 35–60.		

Table 2. Selected EVM Metrics

Metric	Formula
CPI is Earned Value divided by Actual Cost = (BCWP/ACWP)	2
SPI is Earned Value divided by Planned Cost = (BCWP/BCWS)	3
BCWS represented by % Scheduled = (BCWS/PMB) * 100	4
BCWP represented by % Complete = (BCWP/PMB) * 100	5
ACWP represented by % Spent = (ACWP/PMB) * 100	6
EAC represented by % VAC = (PMB – EAC) * 100/PMB	7
<i>Note.</i> Remaining management reserve (MR) not included in PMB for all calculations.	

Table 3. EAC Range
Case 1 – CAIV Single Point Adjustment
>\$100 Million Software Development Contract

	Before SPA	After SPA	3 Months after SPA	6 Months after SPA	13 Months after SPA
Traditional Floor					
% VAC	-21.4	-0.8	-0.2	-1.1	-1.5
CPI _{cum} EAC	Lowest	Lowest	Lowest	Lowest	Lowest
% VAC	-24.8	-0.9	-0.5	-1.4	-1.5
Traditional Ceiling					
% VAC	-63.3	-1.6	-1.8	-2.6	-1.9
CPI x SPI EAC	Highest	Highest	Highest	Highest	Highest
% Complete	33.5	46.5	56.2	65.2	87.9

Table 4. EAC Range
Case 2 – Single Point Adjustment of Level 4 WBS
>\$400 Million Summary Level WBS in
>\$1.5 Billion MDAP Development

	Before 1st SPA	After 1st SPA	Before Rebaseline	After Rebaseline	3 Months Rebaseline	5 Months Rebaseline
Traditional Floor						
% VAC	-10.4	-0.1	-10.6	+1.8	-0.9	-3.8
CPI _{cum} EAC		Lowest		Lowest	Lowest	Lowest
% VAC	-9.1	-0.2	-10.6	+1.5	-1.2	-4.0
80/20 EAC	Lowest		Lowest			
Traditional Ceiling						
% VAC	-10.4	-1.5	-13.1	+1.2	-2.4	-6.8
CPI x SPI EAC	Highest	Highest	Highest	Highest	Highest	Highest
% Complete	47.3	61.0	78.1	36.6	48.0	55.7

Single Point Adjustments

Table 5. EAC Range
Case 3 – Single Point Adjustment of BCWS Only
>\$400 Million Weapon System Enhancement

	Before SPA	After SPA	3 Months after SPA	4 Months after SPA
Traditional Floor % VAC CPI _{cum} EAC	-4.8 Lowest	-4.7	-5.7	-6.2
% VAC 80/20 EAC	-4.9	-4.4 Lowest	-5.3 Lowest	-5.8 Lowest
Traditional Ceiling % VAC CPI x SPI EAC	-6.8 Highest	-4.7 Highest	-5.8 Highest	-6.6 Highest
% Complete	72.0	72.9	68.8	72.4

Table 6. EAC Range
Case 4 – Single Point Adjustment
\$50 Million Integration Study Contract –
At 50% Complete, Descoped 8%

	Descope 5 Months Before SPA	Before SPA	After SPA	3 Months after SPA
Traditional Floor % VAC CPI _{cum} EAC	+4.0 Lowest	+4.2 Lowest	0.0	-5.3 Lowest
% VAC 80/20 EAC	+3.6	+4.0	0.0	-5.7
Traditional Ceiling % VAC CPI x SPI EAC	+3.6 Highest	+4.0 Highest	0.0	-5.8 Highest
% Complete	59.7	74.0	74.8	84.9
EAC	\$42.4 M	\$42.3 M'	\$44.1 M	\$44.5 M

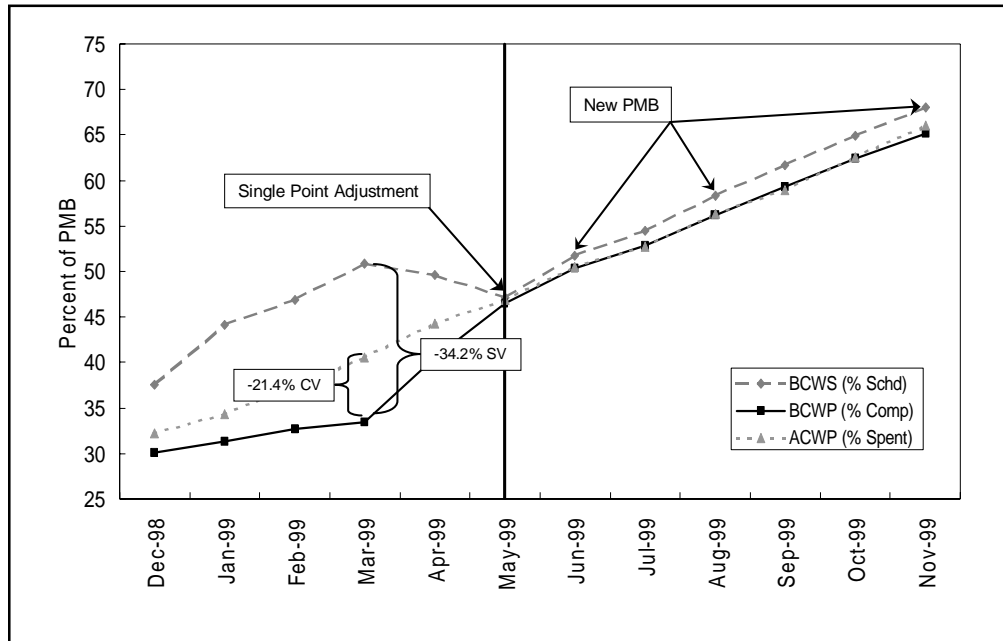


Figure 1A. BCWS, BCWP, & ACWP.
Case 1 – CAIV Single Point Adjustment –
> \$100 Million Software Development Contract.

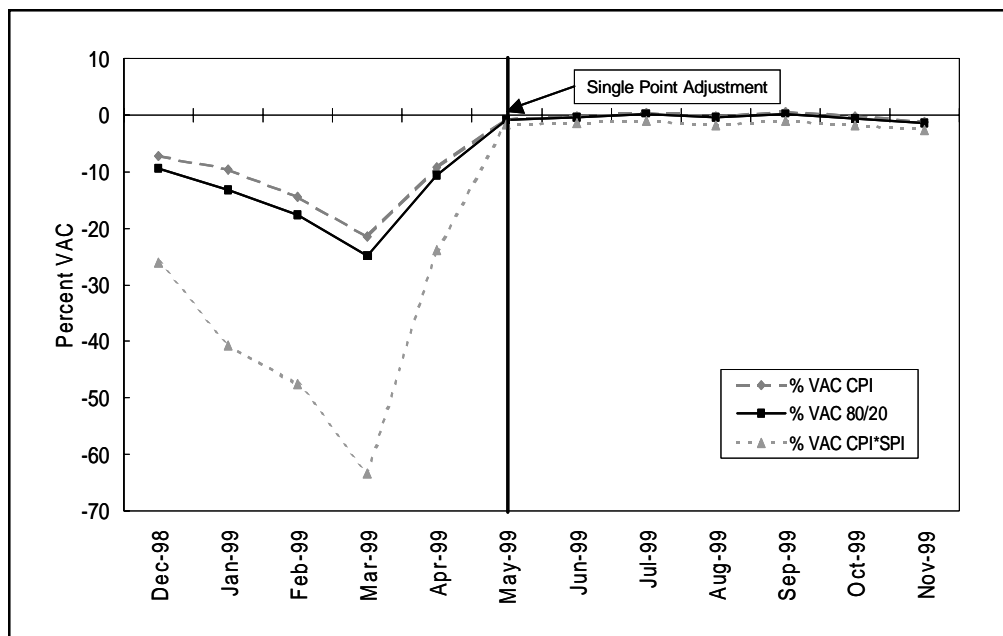


Figure 1B. VAC.
Case 1 – CAIV Single Point Adjustment –
> \$100 Million Software Development Contract.

Single Point Adjustments

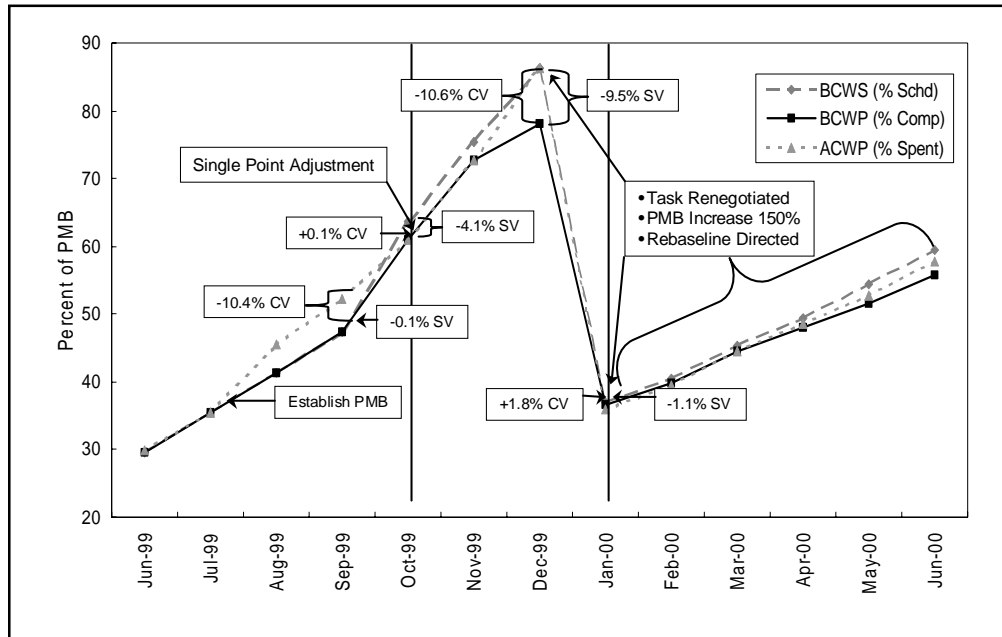


Figure 2A. BCWS, BCWP & ACWP.
Case 2 – Single Point Adjustment of Level 4 WBS –
>\$400 Million Summary Level WBS in
>\$1.5 Billion MDAP Development.

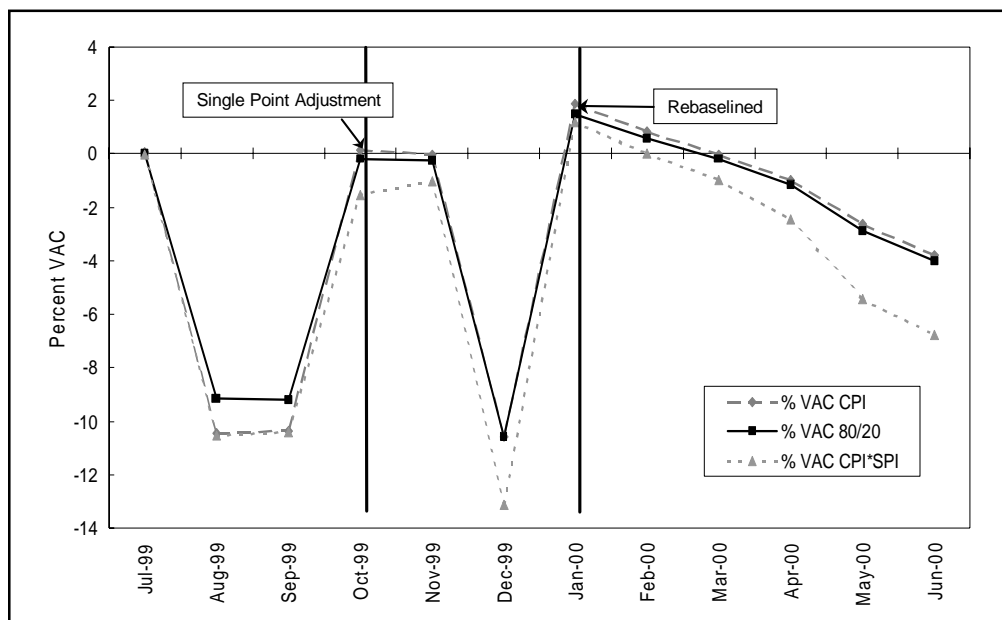


Figure 2B. VAC.
Case 2 – Single Point Adjustment of Level 4 WBS –
>\$400 Million Summary Level WBS in
>\$1.5 Billion MDAP Development.

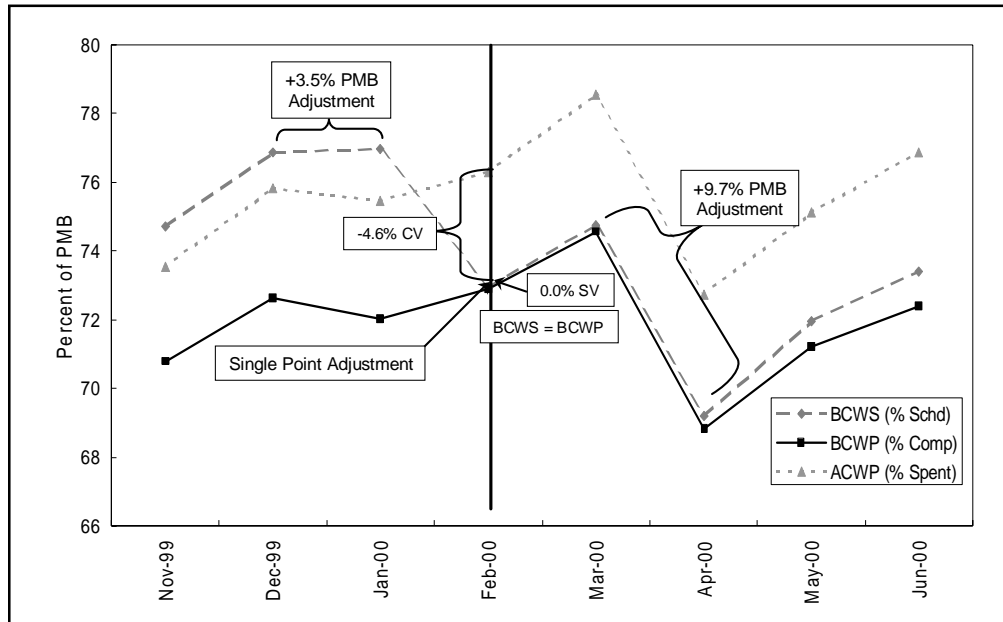


Figure 3A. BCWS, BCWP & ACWP.
Case 3 – Single Point Adjustment of BCWS Only –
>\$400 Million Weapon System Enhancement.

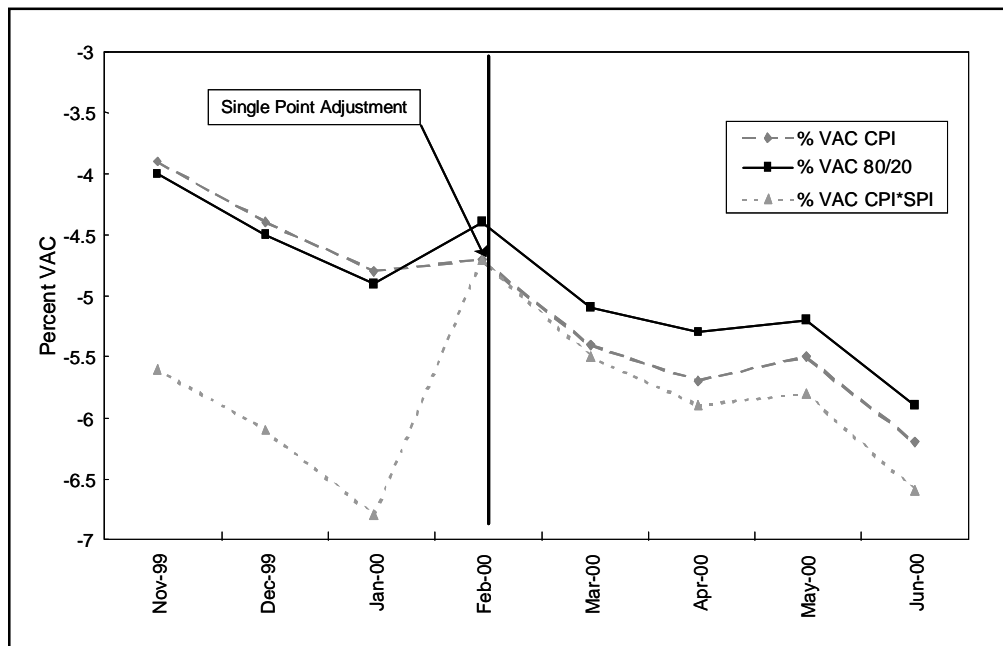


Figure 3B. VAC.
Case 3 – Single Point Adjustment of BCWS Only –
>\$400 Million Weapon System Enhancement.



Single Point Adjustments

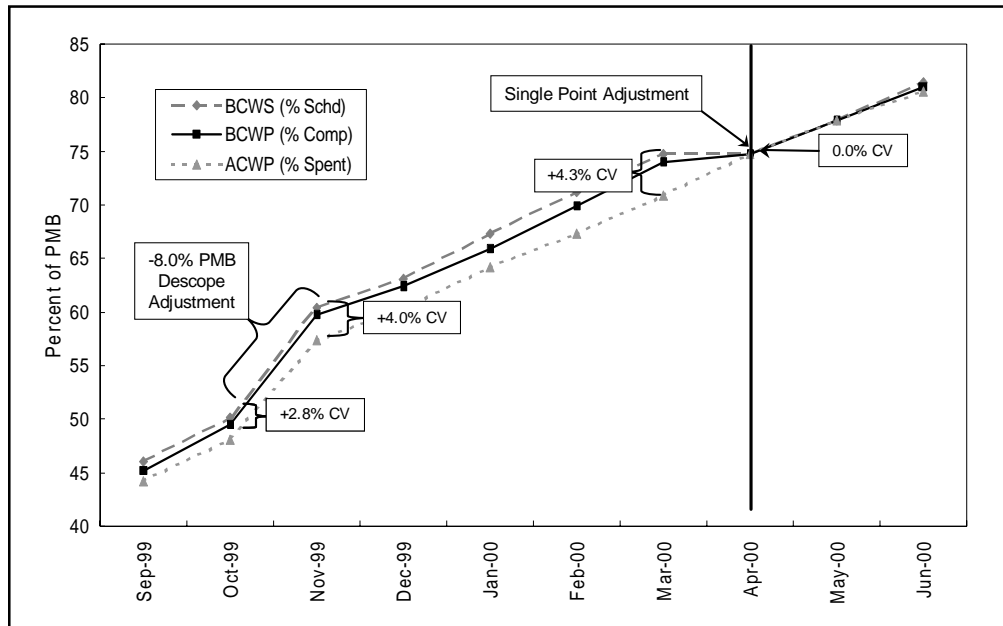


Figure 4A. BCWS, BCWP & ACWP.
Case 4 - Single Point Adjustment - \$50 Million Integration Study Contract - At 50% Complete, Descoped 8%.

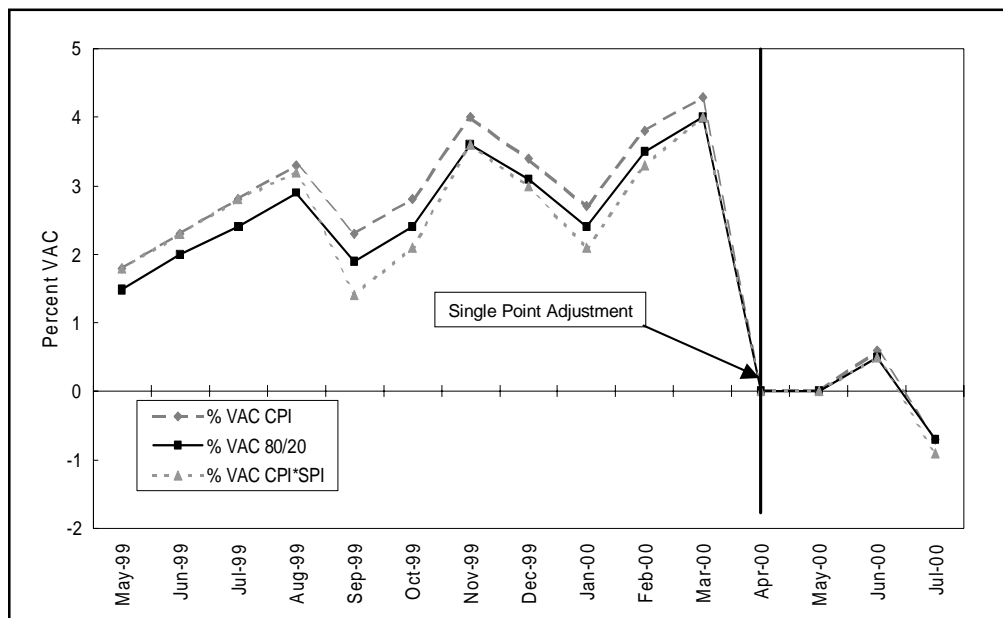


Figure 4B. VAC.
Case 4 - Single Point Adjustment - \$50 Million Integration Study Contract - At 50% Complete, Descoped 8%.



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